UTILIZATION OF BIOMASS FOR BRIQUETTING IN BANGLADESH

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Abstract Biomass is the biggest source among all other sources of energy in Bangladesh. But due to inefficient use of the same the country is loosing a large amount of energy every year. The available source is rice husk, wheat husk, sawdust, rice straw etc. These residues have low heat release rate per unit volume and high transportation and storage costs when used as received condition. In Bangladesh biomass residues are conventionally used as roofing material, cattle feed, raw material for paper mills, direct burning (for cooking) etc. Briquetting of biomass is an economically viable solution to these problems. The information obtained from the physical survey suggests that about 3,537 thousand Metric Tons of rice husk 117 thousand Metric Tons of sawdust, 1,470 thousand Metric Tons of wheat straw, 2,607 thousand Metric Tons of bagasse and 22,928 thousand Metric Tons of rice straw are produced annually. At present about 907 briquetting machines are running in Bangladesh. In a robust calculation it is found that about 18,500 machines can run with the available source of biomass residue. In Bangladesh mainly heated – die screw – press type machine is normally used. The main problem of this machine is the life of screw. Mainly the tips of the screw wear within a very short time (3 – 4 hours). Resurfacing by XHD N6715 and Chrom Carb N6006 increase the life of the screw. Finally two electrodes are selected for resurfacing of the screw (Duroid 650R and hard craft 650 N), which shows good result and locally available in the market. Tapered die also increase the life of the screw.

Keywords: Briquetting, biomass, rice husk, screw, die, screw life, screw wear

INTRODUCTION

Bangladesh is an agriculture based country. More than seventy five percent of her total population live in rural areas. The energy consumption of almost all the rural people lies in cooking and house hold lighting. A report of study showed that the contribution of biomass energy in meeting the total national energy consumption in Bangladesh is about 73%[1]. Every year enormous amount of biomass residues are available from agricultural and forestry sectors. The conventional use of these biomass residues are as roofing materials, cattle feed, raw materials for paper and pulp industries etc. But their use as source of energy is not as easy as other conventional sources. The biomass waste like rice husk, rice straw, wheat straw, maize stalk, saw dust, bagasse, coconut coir, groundnut shell etc. have high energy content. These residues, found in a variety of forms, have high moisture content and low bulk density. Because of the fact, these biomass residues have low heat release per unit volume and high transportation and storage costs when used as received condition. Briquetting Technology refers to the process of compaction of biomass residues between rollers and cavities into a product of regular shaped higher bulk density than that of original raw materials. The term briquetting or densification is a very old concept, which was first patented in 1864. Since then, very many patents have been filed in particular at the beginning of this century. Several densification methods are available commercially, namely, pelleting, cubing, rolling compaction and briquetting. By briquetting the product obtained in the form of long solid cylinders. Briquetting is the process of converting low bulk density materials into high bulk density materials [2]. The process uses a screw to force the feed stock under high pressure into a heated die there forming large cylinders 2.5 to 10 cm in diameter. Normally the die temperature is maintained between 250^{o} C to 300^{o} C. The raw materials get heated up to 220^{o} C in this process. The concept is to heat the biomass at a temperature which is sufficient enough to soften the lignin, which is one of the major component of all types of vegetation, as well as pushing through the die to get it compacted. In this process lignin itself works, as the binding material so there is no need to add any additional binder. The briquette has calorific value ranging from 14.2 to 17.5 MJ/kg [3] depending upon the raw materials used. The ash content is only 8-20%. Therefore, this technology can help in expanding the use of biomass residues for energy use and also to improve the energy situation in rural areas.

This paper presents an outlook about the status of briquetting technology in Bangladesh. Especially the R & D activities in BIT Khulna. Recently a project on biomass briquetting financed by Swedish International Development Co-operation Agency (SIDA) and currently executed by the Asian Institute of Technology (AIT) was conducted by the Mechanical Engineering

Department, Bangladesh Institute of Technology (BIT), Khulna.

ASSESSMENT OF RAW MATERIAL FOR BRIQUETTING

A survey was carried out to identify the locally available raw materials for briquetting. The result of the survey shows a bright prospect of this technology if it can be applied in a systematic way. A wide variety of biomass residues are available which can be converted to get solid fuel through briquetting. Residues such as rice husk, sawdust is in a ready-to-use from. Other residues such as rice straw, wheat straw, wheat shell, bagasse, groundnut shell etc. can be densified after chopping or grinding. The availability of the raw materials varies from place to place throughout the country. The information obtained from physical survey reports that about 3537 thousand M. Ton rice husk, 117 thousand M. Ton saw dust, 1470 thousand M. Ton wheat straw 2607 thousand M. Ton bagasse, 22928 thousand M. Ton rice straw are produced annually [4]. The availability of rice husk, rice straw, wheat husk, wheat straw, groundnut in the different districts of Bangladesh are shown in Tab.1. Production of the rice husk and rice straw were calculated on the basis of 20% and 130% of rice production respectively. From Tab. 1 it is evident that rice husk and the rice straw are the potential sources for briquetting in Bangladesh. In a robust calculation it was found that about 7000, 294, 7640, 4, 3600, 14 machines can run by rice husk, saw dust, rice straw, bagasse, wastes from wheat, ground nut respectively.

STATUS OF BRIQUETTING TECHNOLOGY IN BANGLADESH

Briquetting Technology in Bangladesh

Biomass briquetting is a relatively recent developed technology in Bangladesh. The briquetting machines used here are of heated die screw press type, similar to briquetting machines commonly used in a number of other countries of the region. In Bangladesh briquetting technology is used for making briquettes mainly from rice husk in some areas. Here in our country, there are some unemployment problem. So few people are doing this job as a means of income source not as to efficient use of biomass wastes. That is why the technology is using in a very haphazard way. So far knowledge goes, the work was first started in Sheikh ghat, Sylhet by importing machine from Taiwan. Later they fabricated similar type of machine and continued the work in a very slow manner. Gradually the technology was spread to Khulna, Chittagong, Dinajpur, Rangpur, Bogra, Jessore, Satkhira and several places of Bangladesh. All these machines are of screw press type (BCSIR imported one piston press type machine in about 1960).

Survey was also conducted to identify the present status of the briquetting machine in the country and the problems encountered by the owners and users of the machines. Table 2 shows the number of briquetting machine at present working at different districts of Bangladesh [3]. From Tab.2, it is clear that the distribution of the briquetting machines is not uniform all over the country.

Problems of briquette making

In our survey work, it was found in all areas of Bangladesh that the main problem of running the machine is the screw wear. In Khulna, Sylhet, Dinajpur and Chittagong region few technicians themselves started this work along with a welding and a grinding machine. Firstly they make the screw with mild steel and directly use it. It lasts for about 3 to 4 hours. A rigorous study show that all the screw wear takes place at the tip, approximately 15 cm from the front end [4]. The worn out rate of the screw surface and flights are dependent upon the material characteristics. Also, abrasiveness of the raw materials increases the wear. Repairing of the screw causes interruption in the work and also one screw can not be repaired more then 10 times. Therefore, the cost of screw becomes the main reason to hinder the technology. The screw repairing cost is shown in Table 3 [5].

RESULTS AND DISCUSSION

Results

The results of few tests have been shown below. The discussion is limited within the following areas.

Resurfacing

Screw surface was repaired with the help of electrodes. A large number of different types of electrodes were tested. After resurfacing the Microflow alloy powder was deposited on the screw surface. With this actions the life of screw was found the increase upto 22 hours in one run within the limit of experiments.

Product Quality

The quality of the product is mainly dependent on the raw materials and the experimental conditions. Among all other factors temperature of the die plays an important role in developing the quality of the product. It is found that the fixed carbon content increases but moisture content and volatile matter content decreases with the increase of die temperature.

Cost Analysis

Cost of briquette production depends on a large number of factors. These include raw material, system used, energy cost, type of briquette burning stove etc. Cost of production of briquette using the following ten systems are shown Table –4.

Electric system:

Option

1. Electric motor operated machine with electric die heater
2. Electric motor operated machine with Kerosene die heater
3. Electric motor operated machine with Briquette burning die heater I
4. Electric motor operated machine with Briquette burning die heater II
5. Electric motor operated machine with Brick briquetting burning die heater

Diesel system:

Option

1. Diesel Engine operated machine with electric die heater
2. Diesel Engine operated machine with Kerosene die heater
3. Diesel Engine operated machine with Briquette burning die heater I
4. Diesel Engine operated machine with Briquette burning die heater II
5. Diesel Engine operated machine with Brick briquetting burning die heater

Economic analysis of Briquetting System

Economic analysis of briquetting system carried out for five different die heating system and also for electric and diesel engine driven system. The analysis is based on 10 hours of operation per day and 25 days per month. The production rate of the machine was considered to 80 kg/hr. The life of Electric and Diesel operated machine was considered to 10 and 8 years respectively. A total life of screw was considered to 222 hours and the interest rate was taken to 10%. It was found that the pay back period is 1.42 years and 0.6 years for the electric and diesel system respectively. In both the cases the benefit cost ratio is higher then 1.0 as shown in the table 5.

DISCUSSION

The aim of this project was to develop the briquetting technology to such a position that it could influence the socio-economic condition of the society as well as to improve the fuel sector of the country.

A new screw lasts for only about 3 – 4 hours after which it needs resurfacing. For this purpose, several electrodes were used. The electrodes which gave better result includes Hard craft, Duroid 650 R, Chrom Carb N6006, Electrode 6HSS, Electrode 700, XHD2222, and XHDN6715. It was observed that welding of the screw tip by the XHDN6715 and Chrom Carb N6006 shows very good result but it is not available in the local market at the same time it is costly. To overcome this problem Duroid 650R and hard craft 650B were suggested to use for the purpose.

It is observed that the screw life can be increased upto a maximum of 22 hours when XHDN6715is used for resurfacing and EWAC1002 is deposited on the surface.

The quality of the product is found to depend on the raw material and the temperature of the die. From experimental result it is observed that sawdust shows the better raw material and 300^0C is a reasonable temperature of die for good products.

Table 4 shows the comparative cost of production of briquette. It is found that the minimum cost of production (Tk.1.51/kg) of briquette is obtained when diesel engine is used for operating the machine and option – 4 is used as die heater in diesel system The production cost is Taka 1.71 /kg for electric system using same option (option 4)

Table 5 shows the summary of economic analysis of the system. The benefit cost ratio is found to 1.12 to 1.33 and the pay back period is found to 1.42 years and 0.6 years for electric and diesel system respectively. So it is evident that the system is both technically and economically feasible to use.

For Bangladesh diesel operated system is an alternative of electric motor operated system as more than 80% of her people are not under electricity network at present. Although presently rice husk is the only raw material used but it is possible to make briquette from rice straw, wheat straw, bagasse etc.

CONCLUSION

1. Chrom Carb N6006 or XHD N6715, Duroid 650R or hard craft 650B electrode can increase the screw life but Duroid 650R or hard craft 650B are more economical than Chrom Carb N6006 or XHD N6715.
2. Biomass Briquetting is both economically and technologically feasible in Bangladesh.
3. Diesel engine operated machine with briquette burning die heater is the most suitable and economical system of producing briquette in Bangladesh.

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Table1: Distribution of Raw materials for briquetting in different regions (thousand M. Ton).

Region (Division)	Rice husk	Rice straw	Saw Dust	Wheat Shell[a]	Wheat Straw[b]	Groundnut Shell
Dhaka	932	6253	23	26	344	1
Rajshahi	1035	6642	23	55	716	1
Chittagong	603	3857	22	9	123	3
Sylhet	284	1854	14	1	14	0.3
Khulna	441	2735	22	20	261	0.2
Barisal	242	1587	13	1	12	0.2
Total	3537	22928	117	112	1470	5.7

Source: Statistical Year Book 1996, Publish by Breau of statistics Bangladesh

Table 2: Briquetting machine distribution in different region in Bangladesh

Region (Greater District)	Total No. of Briquetting Machine	No. of Foreign machine	Total
Sylhet	233	15	248
Khulna	174	2	102
Chittagong	135	-	103
Rajshahi	268	-	60
Barisal	32	-	23
Dhaka	47	-	04
Total	889	17	906

Table 3: Comparison of screw repairing cost by using different electrode.

Consideration; machine operation = 10 hrs/day; and 300 days/ year, no of screw =1, average production rate = 80 kg/hr. One screw can be used 10 times by repairing.

	Hard Craft 650 B	Duroid 650R	Chrom Carb 6006	XHD N6715
Initial screw Life (hr)	2	2	2	2
Screw life after one run (hr)	6	7.5	15	22
Screw life after ten run (hr)**	60	75	150	220
Total screw life (hr)	62	77	152	222
Total production per screw (kg)	4960	6160	12160	17760
Primary cost of screw (Taka)	600	600	600	600
Screw repairing cost per run (Taka)*	75	75	200	220
Screw repairing cost after 10 run (Taka)	750	750	2000	2200
Total cost (Taka)	1350	1350	2600	2800
Screw cost per hour (Taka/hr)	21.77	17.53	17.11	12.61

Table 4: Production cost of briquette different options

Type of Cost	Electric System					Diesel Engine System				
	Amount Taka/hr					Amount Taka/hr				
Option ⟶	1	2	3	4	5	1	2	3	4	5
Total Fixed Cost	2.08	2.08	2.08	2.08	2.08	2.23	2.23	2.23	2.23	2.23
Total Variable Cost	160.85	152.85	143.25	140.85	144.05	135.85	127.85	118.25	115.85	119.05
Machine Depreciation Cost	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2
Maintenance Cost	1.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5
Total Cost	162.85	154.85	145.25	142.85	144.05	140.78	132.78	123.18	120.78	123.98
Unit cost Taka/kg	2.03	1.93	1.82	1.78	1.80	1.76	1.66	1.54	1.51	1.55

Table 5: Outcome of Economic analysis of briquetting system

	Electric System	Diesel System
Total Cost (cost of production of 80 kg of briquette)	142.85	120.78
Sales price of 80 kg of briquette (Taka)	160	160
Net profit in one hour	17.15	39.22
Net profit in per day*	171.50	392.0
Net profit in per year**	51450.00	117660.00
Pay back period	1.42 Years	0.06 Years
Benefit cost ratio	1.12	1.33

***** Per day 10 hours in operation ** Per year 300 days in operation

Note: 2 % factor of safety have been considered during calculation